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G2J JGEAX1 JGEA9 JGEA9P
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(58) Field of Search
UK CL (Edition V) H2E
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Other: Online: WPI, EPODOC, JAPIO

(54) Abstract Title
Field weldable connections with thermal insulation

(57) The invention relates to a splice between two communication cables 1a, 1b, such as electrical cables or optical fibres. Thermal insulators 25a, 25b are used to protect the communication lines 15a, 15b when a weld coupling 35 is welded to the housings (5). A protective housing (45, Fig 4) may be placed over the splice and may be filled with hydraulic oil, epoxy or a gel. The connection can be made in the field and can be used downhole in an oil well.

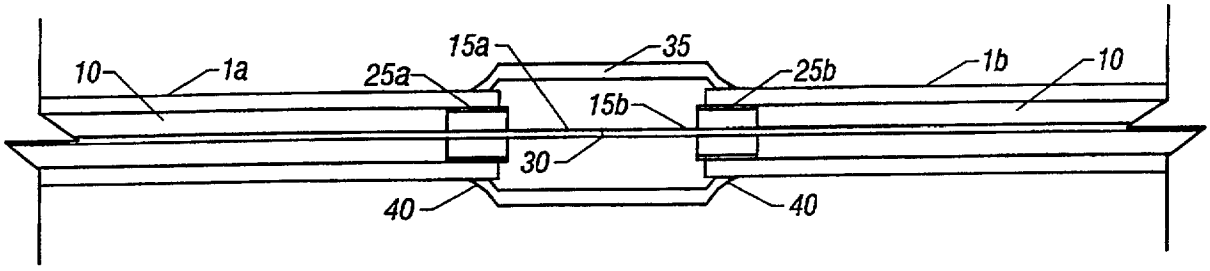

FIG. 3

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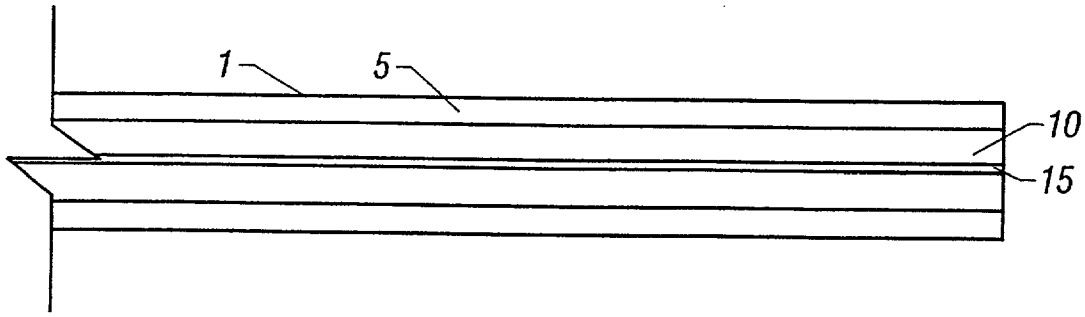

FIG. 1

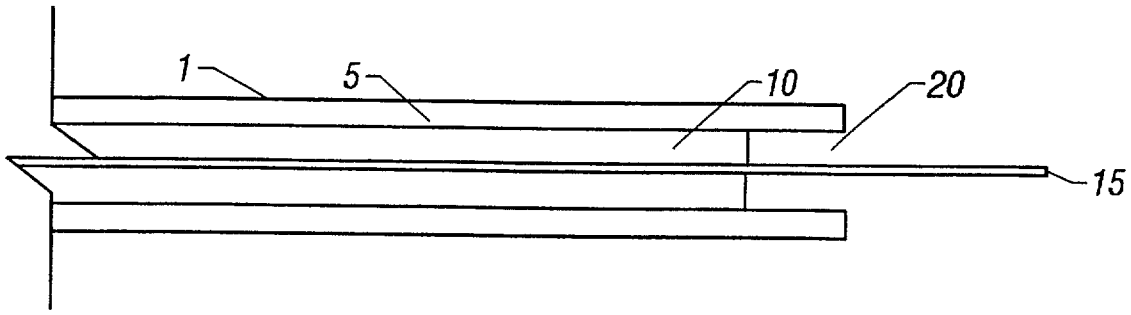

FIG. 2

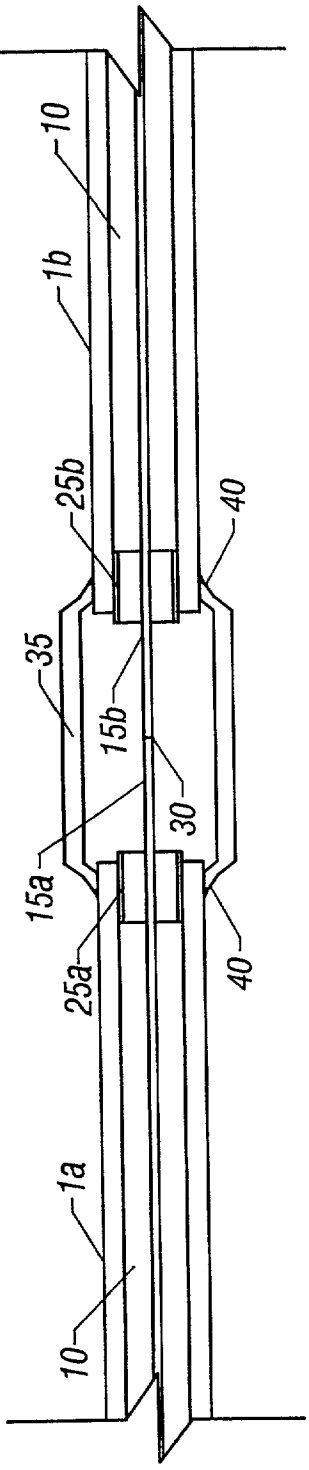

FIG. 3

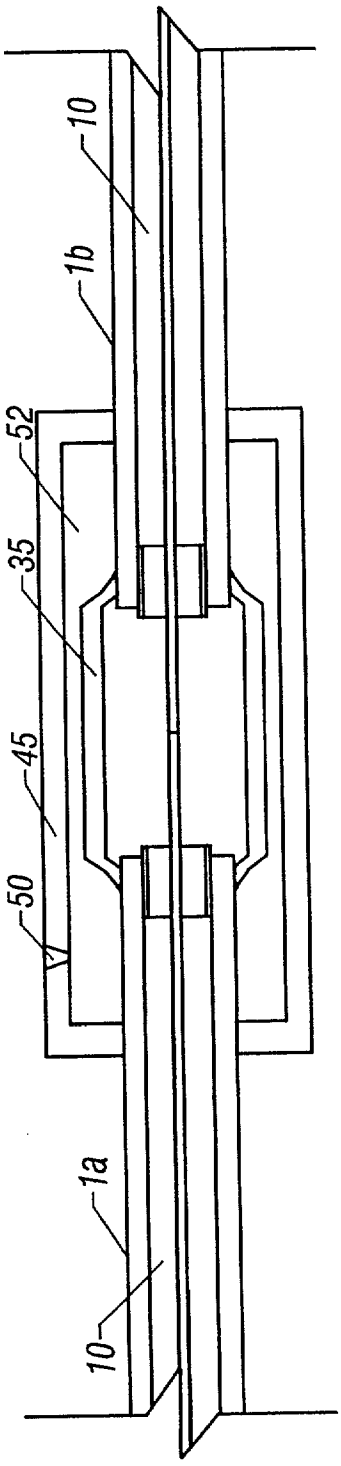

FIG. 4

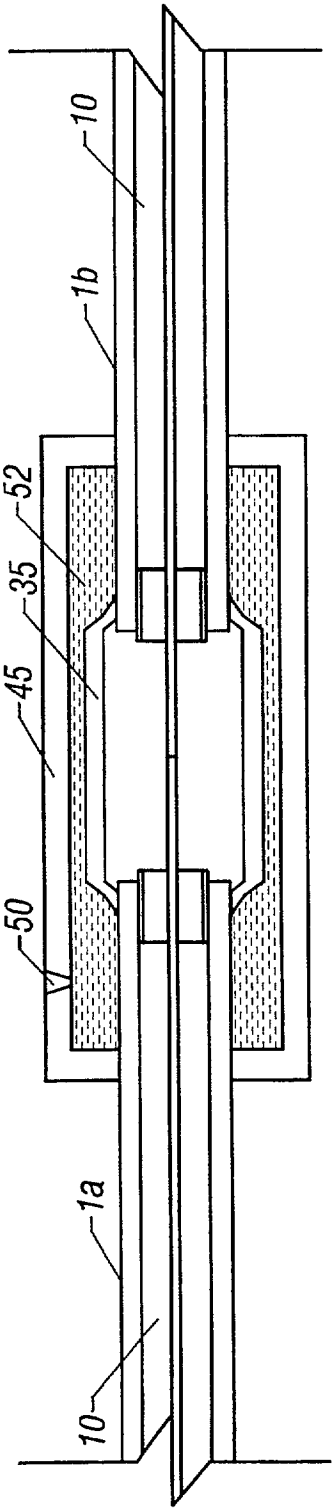

FIG. 5

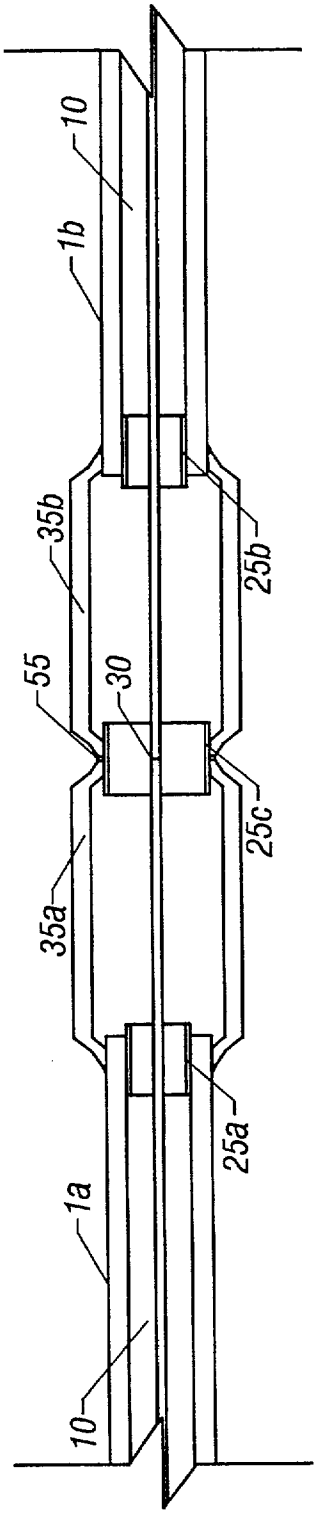

FIG. 6

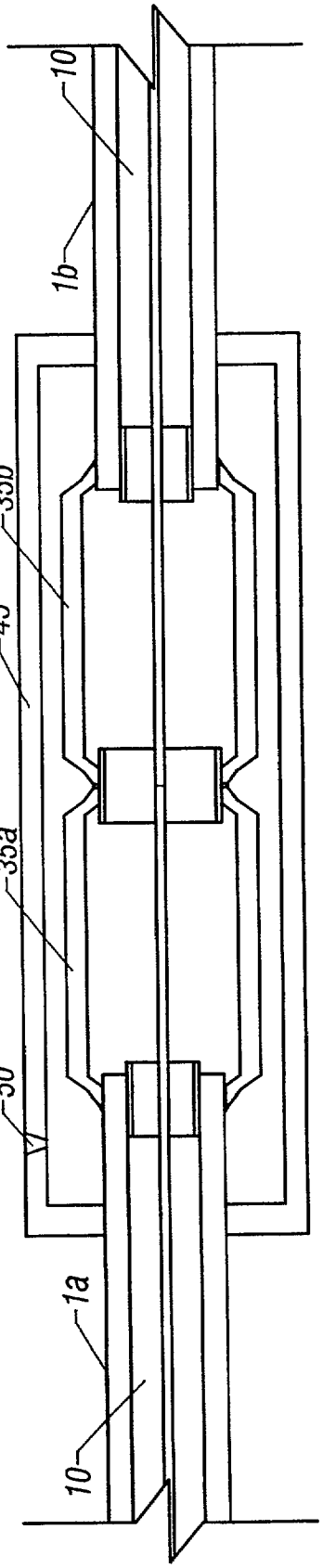

FIG. 7

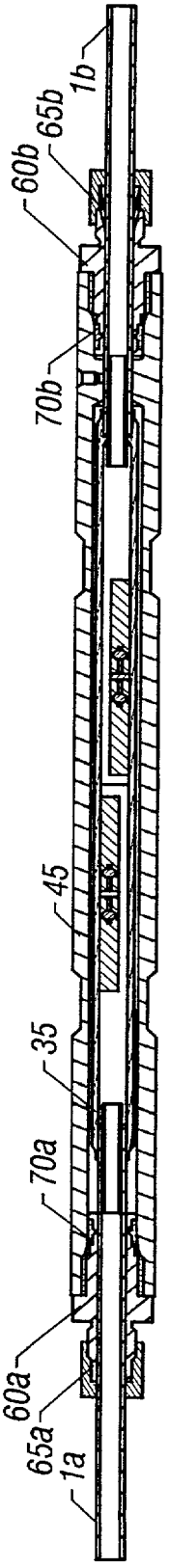

FIG. 8

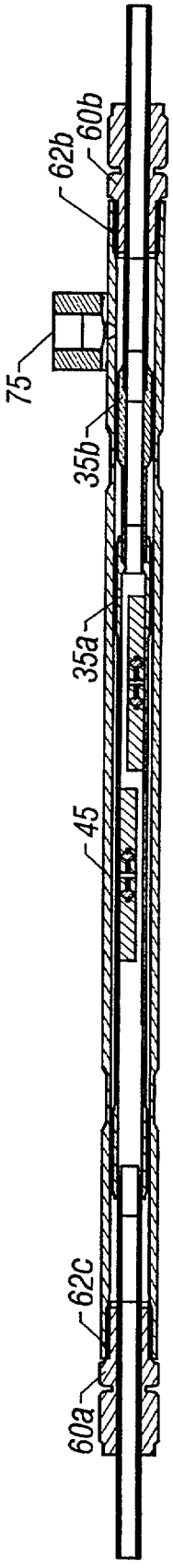

FIG. 9

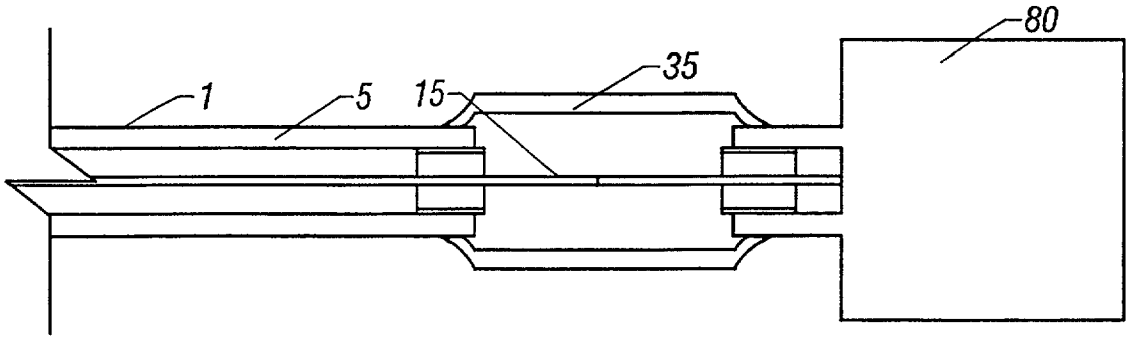

FIG. 10

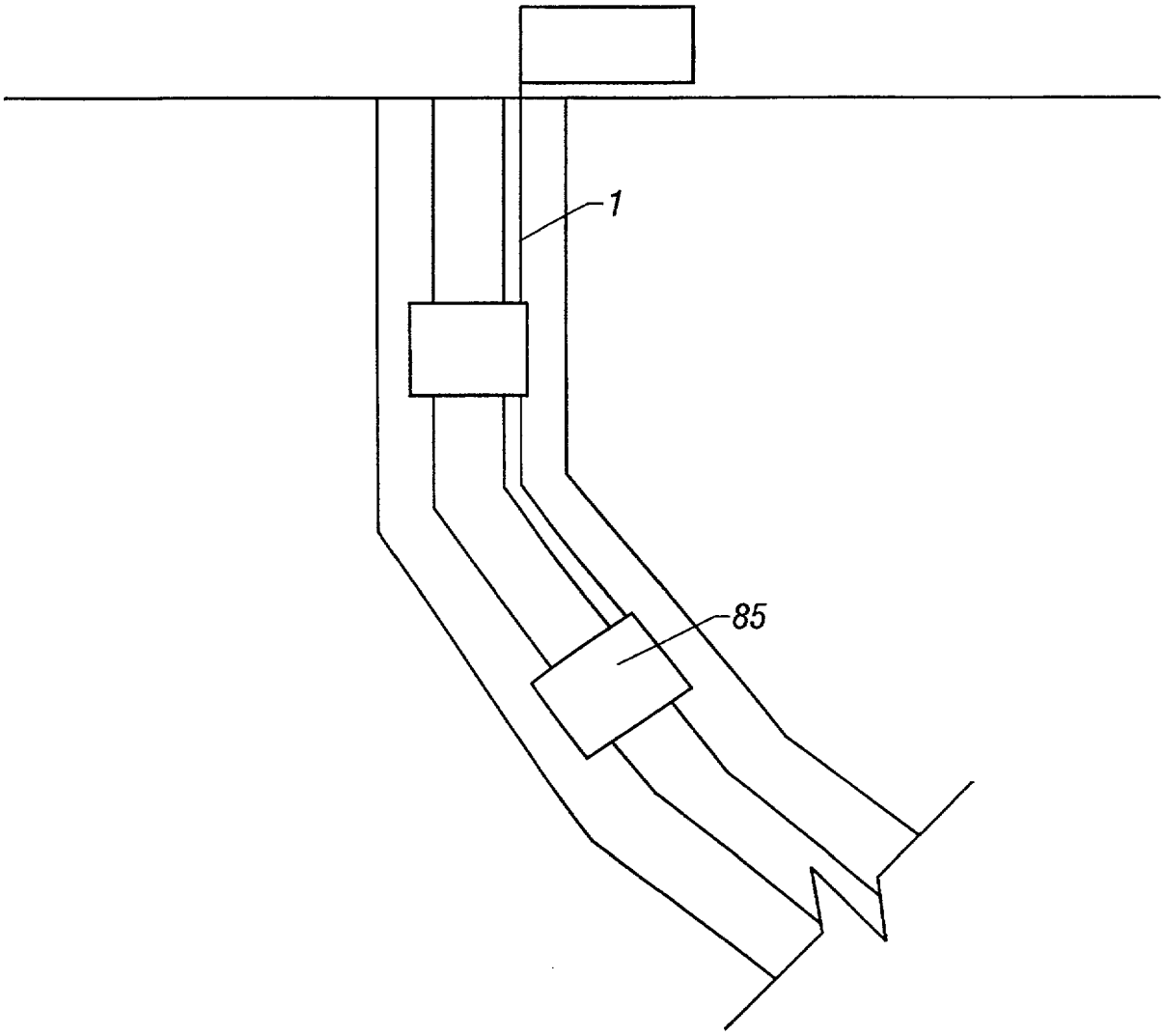

FIG. 11

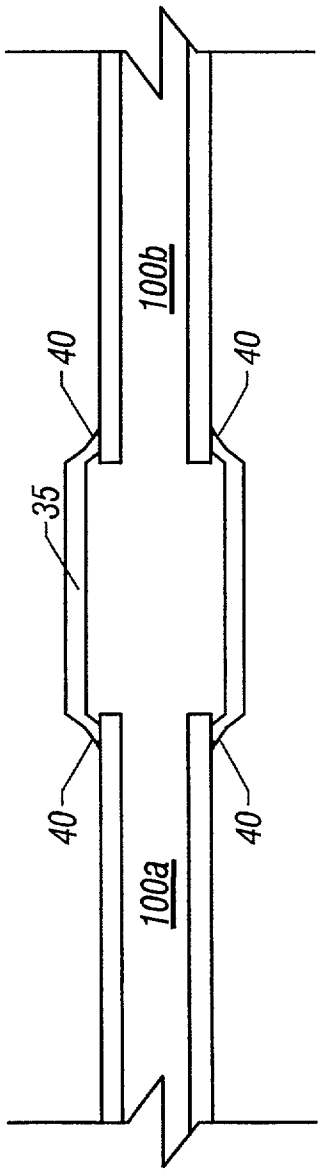

FIG. 12

FIELD WELDABLE CONNECTIONS

FIELD OF THE INVENTION

The subject matter of the present invention relates to communication lines. More specifically, the subject matter of the present invention relates to an apparatus and method of protecting and sealing spliced communication lines.

BACKGROUND OF THE INVENTION

Communication lines are used in a wide range of applications in the oilfield industry. The communication lines transmit monitored data regarding downhole conditions such as temperature and pressure to surface instrumentation. The communication lines can also be used to send information down the well from the surface. Additionally, communication lines may also be used to electrically power downhole equipment. Communication lines may include electrical conduits, optical fibers, and other methods for data or power transmission.

In environments such as those encountered in downhole wells, the communication lines are exposed to hostile conditions such as elevated temperatures and pressures. To protect the fragile communication lines from the hostile conditions, the communication lines are generally carried within protective tubing that provides an environmental seal. Problems arise when the seal must be broken during assembly, installation and/or repair of the communication line. For example, in downhole applications, in order for the communication line to be fed through production equipment such as packers, the line must be cut and then spliced with the downstream line. Thus, after splicing, the communication line must once again be sealed from the harsh environment.

There exists, therefore, a need for an apparatus and method of splicing communication lines that provides structural integrity and protects the communication line from the surrounding environment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sketch of a communication cable.

Figure 2 is a sketch of a section of cable that has been prepared for splicing.

Figure 3 is a sketch of the welded splice assembly.

Figure 4 is a sketch of another embodiment of the welded splice assembly having a pressure housing.

Figure 5 is a sketch of another embodiment of the welded splice assembly having a gel or epoxy material within the pressure housing.

Figure 6 is a sketch of another embodiment of the welded splice assembly having a plurality of weld couplings.

Figure 7 is a sketch of another embodiment of the welded splice assembly having a plurality of weld couplings and a pressure housing.

Figure 8 is a sketch of another embodiment of the welded splice assembly.

Figure 9 is a sketch of another embodiment of the welded splice assembly having a plurality of weld couplings.

Figure 10 is a sketch of another embodiment of the welded splice assembly attached to a tool.

Figure 11 is a sketch of a wellbore completion including a spliced communication line.

Figure 12 provides a sketch of the welded splice assembly used for a hydraulic or fluid conduit.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following detailed description of the subject matter of the present invention, the apparatus and method of splicing communication lines is principally described with reference to downhole well applications. Such description is intended for illustration purposes only and is not intended to limit the scope of the present invention. In addition to downhole well applications, the present invention can be used with any number of applications such as pipeline monitoring, subsea well monitoring, and data transmission, for example. Furthermore, the communication lines may comprise electrical wiring, which may facilitate transfer of information, power, or both. All such types of communication line splicing are intended to fall within the purview of the present invention. However, for purposes of illustration, the present invention will be principally described as being used in downhole well applications. Further as used herein, the term communication line shall refer to those lines comprising electrical lines or fiber optic lines, as well as lines including combinations thereof or combinations with other types of lines.

Figure 1 provides a sketch of a typical cable **1** useful in the present invention. The cable **1** comprises an outer housing **5**, a secondary housing **10**, and one or more communication lines **15**.

The outer housing **5** provides the structural integrity for the communication line **1** and protects the communication lines **15** from the surrounding environment. Further, the outer housing **5** provides structural protection for the communication lines **15** from damage caused by the cable **1** impacting, or being impacted by, nearby tools and equipment. In one embodiment, the outer housing **5** is comprised of a metallic material such as steel, or other metallic alloys, for example. The secondary housing **10** resides within the outer housing **5** and provides protection for the communication lines **15** contained within. In one embodiment, shown in Fig. 1, the secondary housing **10** is made from a polymeric material.

Figure 2 provides a sketch of a segment of cable that has been prepared for splicing. The cable **1** has been cut so that the communication line **15** extends longitudinally beyond the outer housing **5** and the secondary housing **10**. Afterwards, a portion of the secondary housing **10** is removed in order to create a void **20**, which is defined by the outer housing **5** and the secondary housing **10**.

Figure 3 provides a sketch illustrating the communication line splice of the present invention. In Fig. 3, the two communication lines being spliced are designated **15a** and **15b**. Once the cables **1a, 1b** have been prepared for splicing, thermal insulators **25a, 25b** are inserted into the void **20** (shown in Fig. 2) so that the insulators **25a, 25b** lie between the outer housing **5** and the communication lines **15a, 25b**. The insulators **25a, 25b** protect the communication lines **15a, 15b** from the heat of the welding. Additionally, the insulators **25a, 25b** prevent the secondary housing from melting and outgassing, which can result in poor weld quality. Prior to splicing, a weld coupling **35** is slid over one of the cables **1a, 1b**. The cleaved communication lines **15a, 15b** are then spliced together by conventional techniques, such that the communication lines **15a, 15b** are operatively connected at the splice **30.** The weld coupling **35** is then slid to cover the ends of both cables **1a, 1b**, and the weld coupling **35** is secured in place by welds **40**. In one embodiment the welds **40** are formed using an orbital welder. Once welded, the weld coupling **35** protects the splice **30** from corrosion, erosion, and physical damage resulting from environmental and operational conditions. Additional protection is provided against hydrocarbon darkening resulting from contact with conductive fluid.

Figure 4 provides a sketch of another embodiment of the weld assembly. In this embodiment, a pressure housing **45** fits over the weld coupling **35**. The pressure housing **45** is slid over the same cable **1a, 1b** as the weld coupling **35**, but is slid prior to the sliding of the weld

coupling **35**. After splicing and after the weld coupling **35** is secured in place, the pressure housing **45** is attached to the cables **1a, 1b** such that the weld coupling **35** is isolated from environmental conditions. For example the housing may be attached by welding, ferrules, or elastomeric seals, among other means. A port **50**, located in the pressure housing **45** enables pressure testing of the welded assembly.

Figure 5 provides a sketch of another embodiment of the weld assembly. In this embodiment a gel or epoxy material is pumped through the port into a cavity **52** defined by the pressure housing **45**, the cables **1a, 1b**, and the weld coupling **35**. This fluid is used for pressure testing. The fluid is pumped into the cavity **52** at a high pressure, and the welded splice assembly is monitored for signs of failure. After pumping, the port **50** is plugged to seal in the viscous fluid. When the spliced section of cable is installed downhole, the viscous fluid cures and hardens due to the high downhole temperatures. The cured material thus provides additional protection for the splice **30** against erosion, corrosion, and other environmental conditions.

Figure 6 provides a sketch of another embodiment of the weld assembly having a plurality of weld couplings **35a, 35b**. The embodiment shown in Figure 6 shows two couplings, but any number can be used and remain within the purview of the invention. The first weld coupling **35a** is slid over the first cable **1a** and the second weld coupling **35b** is slid over the second cable **1b**. An additional thermal insulator **25c** is inserted to protect the splice **30** at the housing junction **55**. After the cables **1a, 1b** are spliced, the first weld coupling **35a** is welded to the first cable **1a** and the second weld coupling **35b** is welded to the second cable **1b**. The first weld coupling **35a** is then welded to the second weld coupling **35b** at the housing junction **55**, thereby enclosing the splice **30**. In this manner, both welds near the secondary housing **10** are formed prior to the weld couplings **35a, 35b** being sealed to the surrounding environment. Thus, any resulting outgassing of the secondary housing **10** is able to escape to the environment and does not affect the weld quality.

Figure 7 provides a sketch of another embodiment of the weld assembly. In this embodiment, the pressure housing **45** protects the two weld couplings **35a, 35b** against erosion and other damaging environmental conditions. The pressure housing **45**, through its port **50**, enables testing of the welded connections with a standard fluid for pressure testing, such as hydraulic oil, or by a different viscous fluid, such as a gel or epoxy material.

Figure 8 provides a sketch of another embodiment of the pressure housing **45**. In this embodiment, the pressure housing **45** is attached to the cables **1a, 1b** by means of fittings **60a, 60b**. The first fitting **60a** and the pressure housing **45** are slid over the first cable **1a**. The second fitting **60b** is slid over the second cable **1b**. After splicing, the fittings **60a, 60b** and the pressure housing **45** are positioned such that the weld coupling **35** is contained within the pressure housing **45**. The fittings **60a, 60b** are then tightened, thereby sealing the welded connections inside the pressure housing **45**. The fittings **60a, 60b** in this embodiment seal to the cables **1a, 1b** through a dual ferrule system **65**. The fittings **60a, 60b** seal onto the pressure housing **45** by means of an elastomeric seal **70**. These sealing mechanisms **65, 70** are not the only means by which the seals can be made. All mechanisms by which one could sealingly join the pressure housing **45** and the cables **1a, 1b** are intended to fall within the purview of the present invention.

Figure 9 provides a sketch of another embodiment of the splice assembly. In this embodiment, the fittings **60a, 60b** are connected to pressure housing **45** by means of a sealing pipe thread **62**. A removable port **75** is used to pressure test the welded splice assembly.

Figure 10 provides a sketch of another embodiment of the splice assembly. In this embodiment, communication line **15** is spliced to a downhole tool **80**. The weld coupling **35** is welded to the outer housing **5** on one side and a section of the tool **80** on the opposite side.

Figure 11 provides a sketch of a wellbore completion including a spliced communication line. The cable **1** is installed downhole to communicate with or power a piece of downhole equipment **85**. The equipment **85** may be controlled by a controller located at the surface.

Figure 12 provides a sketch of the welded splice assembly used for a hydraulic or fluid conduit. In Fig. 12, a weld coupling **35** is secured over the spliced hydraulic or fluid conduits **100a,100b** by welds **40**. Once welded, the resulting spliced hydraulic or fluid line can be pressure tested prior to placement downhole.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such are intended to be included within the scope of the following non-limiting claims:

CLAIMS

1. A downhole connector assembly for sealingly attaching a first and a second segment of a control line having a communication line therein, comprising:
at least one weld coupling; and
at least one thermal insulator, said thermal insulator being located between the communication line and the weld coupling.

2. The downhole connector assembly of claim 1, further comprising a protective housing containing the at least one weld coupling therein.

3. The downhole connector assembly of claim 1, wherein the protective housing is filled with an epoxy.

4. The downhole connector assembly of claim 1, wherein the protective housing is filled with a gel.

5. The downhole connector assembly of claim 2, wherein the protective housing futher comprises a port adapted for pressure testing the downhole connector assembly.

6. A protective splice assembly, comprising:
a first cable having an outer housing and a communication line therein;
a second cable having an outer housing and a communication line therein;
a spliced connection between the communication lines of the first and second cables;
at least one weld coupling located between the outer housings and the communication lines welded to the first and second cables; and
at least one thermal insulator of the first and second cables.

7. The protective splice assembly of claim 6, adapted for downhole application.

8. The protective splice assembly of claim 6, wherein the outer housing is comprised of a metallic material.

9. The protective splice assembly of claim 6, wherein the outer housing is comprised of a steel alloy.

10. The protective splice assembly of claim 6, wherein the communication line transfers data.

11. The protective splice assembly of claim 6, wherein the communication line transfers power.

12. The protective splice assembly of claim 6, wherein the communication line is an electrical line.

13. The protective splice assembly of claim 6, wherein the communication line is a fiber optic line.

14. The protective splice assembly of claim 6, wherein the at least one weld coupling is welded with an orbital welder.

15. The protective splice assembly of claim 6, further comprising a secondary housing located within the outer housing.

16. The protective splice assembly of claim 15, wherein the secondary housing comprises a polymeric material.

17. The protective splice assembly of claim 15, wherein the communication lines extend therethrough the secondary housing.

18. The protective splice assembly of claim 15, wherein the at least one thermal insulator is located between the secondary housing and the outer housing.

19. The protective splice assembly of claim 6, further comprising a pressure housing secured to the first and second cables such that the at least one weld coupling is isolated from the surrounding environment.

20. The protective splice assembly of claim 19, wherein the pressure housing is secured by welding.

21. The protective splice assembly of claim 19, wherein the pressure housing is secured by ferrules.

22. The protective splice assembly of claim 19, wherein the pressure housing is secured by elastomeric seals.

23. The protective splice assembly of claim 19, wherein the pressure housing further comprises a port adapted for pressure testing.

24. The protective splice assembly of claim 19, wherein the pressure housing is filled with a gel.

25. The protective splice assembly of claim 19, wherein the pressure housing is filled with an epoxy.

26. A downhole connector assembly for sealingly attaching a first and a second segment of a control line having a communication line therein, comprising:
at least one weld coupling; and
means for thermally protecting the communication line, said means located between the communication line and the weld coupling.

27. A method for providing a downhole control line, comprising:
providing a first and a second segment of a control line having a communication line therein;
providing a weld coupling;
inserting the first and second segments of the control line into the weld coupling and welding the segments in place; and
providing at least one thermal insulator between the weld coupling and the communication line of the first and second segments.

INVESTOR IN PEOPLE

Application No: GB 0222345.1 **Examiner:** Paul Nicholls
Claims searched: 1 - 27 **Date of search:** 18 March 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	6, 10, 13	DD 0 217 045 A1 (PRUEFFELD) - See thermal insulator 9

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

H2E

Worldwide search of patent documents classified in the following areas of the IPC[7]:

H01R, G02B

The following online and other databases have been used in the preparation of this search report :

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